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Variability of some Nigerian date-palm (*Phoenix dactylifera* L) accessions as revealed by vegetative traits

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ABSTRACT

The date palm (*Phoenix dactylifera* L.) is an economically important species vital for food security in Nigeria, especially for the northern population. This work was carried out on 21 date palm accessions, studying their morphological characteristics. Morphological characters of the tree are also taken into consideration for cultivar identification. Twenty-one female palm trees were randomly selected from the gene pools. From each tree, forty (40) fruits were collected which were then checked for physical damage and injury from insects and fungal infection. The plant height was highest in accession R13P5, while the highest petiole length was recorded in accession R15P6 and R9P2. The width of leaves was highest in accessions R6P20 and R13P5. The girth size in palm crops which indicates evidence of maturity was in accession R5P8. The leaflets arrangement among some accessions either is alternate or opposite in arrangement, However, in some accessions, this character is not stable where some accessions were observed to have both alternate and opposite arrangement with a single leaflet in-between. The accession R5P20 with the highest girth size is however important in the development of breeding programmes for growth selection among the accessions. The results show that the morphological characteristics of the studied accessions vary from one cultivar to another with regard to some quantitative vegetative characteristics that may be very useful for selection in current and future breeding programmes.

INTRODUCTION

Date palm varieties are very similar; however, studies have shown that there are clear differences based on the vegetative characteristics and Spath (Djerouni *et al*., 2015).Since the palm leave constituents look very different, the measurements which were taken from leaf palm like thorns length, pinnae number and leaf palm length have shown the similarities and the differences between the palms (Haider *et al*., 2015).

Genotype identification of date palm is commonly based on morphological characters (Sedra *et al.,* 1998). In date palm most of the female cultivars are recognized by their fruit characteristics such as size, shape, colour and taste along with the morphological characters of the tree for cultivar identification. During the ripening process, the date fruits pass through four distinct stages of maturity, i.e. kimri, beser (khalal), rutaband tamar, (Al-Ghamdi, 1993).

According to Al-Khalifah *et al.* (2012), some date palm cultivars have similar or narrow distinguishing morphological characters that complicate cultivar identification and requires evidence to prove phylogenetic relationships at the interspecific level.

Morphological characterization needs a generous set of phenotypic records that are sometimes problematic to measure as a result of sensitivity to the environmental influences (Rao, 2004). The vegetative parameters are informative for description, phenotypic diversity and phylogenic relationship among date palm ecotypes.

Haider *et al.* (2015), studied assessment of morphological attributes of date palm accessions from Pakistan. From their results, they concluded that quantitative and qualitative traits such as leaves, number of leaflets, length and grouping of spines, spathe, fruit and spideces possess quantitative markers mainly used for identification, description, differentiation and characterization of date palm

Furthermore, Ahmed *et al.* (2016) studied the phenotypic characteristics of 75 cultivars from Algeria, from their findings on the morphological parameters observed, they concluded that the precise number of cultivars is still unknown since the cultivars exhibited homogenous traits and differ mainly by the fruit parameters, and also they are morphologically nearly similar and are of similar denomination.

Despite its great diversity, date-palm is currently menaced by genetic erosion mainly due to abiotic stresses (high seasonal temperature, drought and rainfall irregularities). Since problems of synonymy and homonymy often occur, the establishment of research strategies aiming at the evaluation of the genetic diversity of this local date-palm germplasm has become imperative. Criteria related either to the vegetative or the fruit parameters are useful for cultivar characterization, phenotypic diversity analysis and phylogenic relationship exploration among date-palm ecotypes. Moreover, phenotypic diversity evaluation constitutes an available basic step for the elaboration of a program to improve germplasm management and utilization of any crop (Chang, 1992).

MATERIALS AND METHODS

Exploration and Collection of Plant Materials

A survey and exploration were undertaken to collect the fruits from the population of the Female date palm (*Phoenix dactylifera* L.) trees germplasm across the gene pools in the experimental field of Nigerian Institute for Oil palm Research (NIFOR) date palm research substation, Jigawa state, Nigeria. The Institute has the national mandate for the crops cultivation. The exploration and collection mission were undertaken to Gene pool 1 which contains germplasm originally collected from Sokoto, kebbi and Zamfara States); Gene pool 2 (collections from Kaduna and Katsina State); Gene pool 3 (containing collections from Kano and Jigawa State), Gene pool 4 (which contains germplasm from Bauchi and Gombe State) and Gene pool 5 (containing germplasm from Borno and Yobe State) Nigeria. The collection of fruits were done during the harvesting period between February and March, 2018 which involved a systematic random sampling from selected matured Female trees in all the gene pools. The collected date fruit were checked for physical damage and injury from insects and fungal infection. They were then brought to the Department of Plant Biology, Federal University of Technology, Minna, for studies. The fruits were then depulped (removal of seeds from the fruits). The depulped seeds were packed and sealed in thick polythene bag. Each of the seed samples was assigned an entry number, the gene pool name and palm number.

Description of Study Area

The area for this study are Nigerian Institute for Oil palm Research (NIFOR), Date Palm Research Substation Dutse, Jigawa state where the fruit samples were collected and Federal University of Technology, Minna, Niger state in which the field experiment and some laboratory work was carried out. The substation of NIFOR is situated on latitude $10^{o}14^{1}$N and longitude $4^{O}12^{1}$E.The substation ecology is within the Sudan savannah with annual rainfall of about 600mm per annum and average temperature of 32^{O}C. The soil type is sandy to loam. The Experimental Garden is situated at the Department of Biological Sciences, Federal University of Technology, Minna, Niger State, Nigeria. Geographically, Minna is located in the North central geopolitical zone of Nigeria. It is located within longitude $6^{o}34$ East and latitude $9^{o}36$ north. It covers a long area of 88 square kilometers with an estimated human population of 348,788 (Niger State Ministry of Agriculture 2008). The area has a tropical

climate condition with mean annual temperature, relative humidity and rainfall of 20-30^{o}C, 61% and 1334cm respectively. The climate presents two distinct seasons: a raining season between May and October and a dry season between November and April each year. The vegetation is a typical Guinea savannah type consisting majority of grassland with scattered trees.

GENEPOOL 1
SOURCE : NIFOR DATEPALM MANUAL

GENEPOOL 2
SOURCE : NIFOR DATEPALM MANUAL

GENEPOOL 3
SOURCE : NIFOR DATEPALM MANUAL

GENEPOOL 4
SOURCE : NIFOR DATEPALM MANUAL

GENEPOOL 5
SOURCE : NIFOR DATEPALM MANUAL

Experimental Design and Raising of Nursery

The viable sprouted date seeds were planted and grown in a randomized complete block design (RCBD) with five replicates. Each accession was grown in a polythene bag, with inter and intra block spacing of 2 feets the polythene bags. Three seeds of each accession were planted per hole and later thinned to single plant per stand. Twenty one date seedling plants per row were planted and data were taken from 105 plants per block. All the cultural practices on cultivation of date palm were carried out.

Percentage Emergence

Germination counts were made 7 days after Sowing. Number of seeds showing germination were counted and expressed in percentage (Songsri *et al.,* 2011). The percentage emergence was calculated using the formular below:

$$\text{Germination (\%)} = \frac{No.of\ seeds\ germination}{No.of\ seeds\ sown} \times 100$$

Morphological Parameters

The morphological parameters were determined following a standard descriptor to characterize date

palm by (IPGRI, 2005; Rizk & Sharabasy, 2007). All measurements were performed in triplicate using measuring tape. Specifically, the days to Emergence (DE) were determined as the interval between sowing of seeds and day a germinating seedling emerges above soil level. Plant height (from ground to lowest green leaf) using tape rule. Petiole length was determined using meter rule, width of leaf was determined using metre rule, girth of plant was determined using tape rule, and Leaflets length (cm) was measured using a tape rule. Petiole width (cm) using a tape rule. Length of Internodes was determined using meter rule.

RESULTS AND DISCUSSION

Plant height at different stages of growth

The analysis of variance (ANOVA) revealed interesting variations among the date palm accessions in plant height at different stages of growth. It showed that there were highly significant differences (P<0.05) among the accessions.

The accession with the highest height at four(4) weeks after planting was due to R1P18 but it was not significantly different (P>0.05) from R4P12 but are significantly different from the values of all other accessions. The lowest was recorded in accession R4P29 respectively, no significant differences were observed in accessions R6P20 and R5P8, but are significantly different from all other accessions. At eight (8) weeks after planting, the accession R1P10 showed the highest mean of (27.33), this value is significantly the same with accession ZARIYA, but are significantly different from other accession. The least was recorded in accession R16P31 respectively.

However, the accession R1P10 had the highest height at 12 weeks with the mean value of (30.67), this was closely followed by accession R13P5 with the mean (29.93), and this value was the same with the value obtained in accessions R1P18 but are significantly different from the values of all other accessions statistically. At 16 weeks after planting, the highest mean was due to accession ZARIYA (35.00), followed by R1P10 (32.17), no significant differences were observed in accessions R7P1, R2P4 and R9P12 respectively.

In addition, at 20th weeks after planting, accession ZARIYA was the highest with the mean value of (35.00), this was closely followed by the accession R24P9 ,this value was significantly the same with accession R1P18 but significantly different from all other accessions at P<0.05. While the lowest was due to accession R14P21.

At 24^{th} weeks, the highest accession was due to R13P5 with the mean value (39.00), this was followed by R1P10 (38.67), this value was significantly the same with accession ZARIYA, but are significantly different from the values of all other accessions. The lowest plant height was recorded in accession R13P9 respectively.

Length of petiole (LOP)

The length of petiole showed significant variations among the accessions at P<0.05 as revealed by ANOVA. The highest petiole length was due to accession R15P6 with the mean value (4.27), however, this value is significantly the same with accession R9P2 with the value (4.10), but is significantly different from the values of all other accessions (Table), while accession R24P9 being recorded as the lowest (1.87).

Width of leave

The width of leave showed interesting variations among the accessions at P<0.05,with accession R6P20 recorded to have the highest mean value (3.50), this is followed by accession R13P5, this value is significantly the same with the accessions R16P31, R5P24, R1P18, R5P20, though they are significantly different from all other accessions at P>0.05.however, the lowest leave width was observed in accession R3P22 respectively.

Girth of plant

The girth of plant among the accessions showed highly significant differences at P<0.05 among the accessions. The lowest mean value (5.10) was recorded for accession R13P9, this value was significantly the same with accession R16P31 with the value (5.20) but are significantly different from all other accessions. The highest was recorded for accession R5P20 with the mean value of 10.0, which is significantly different from the value of all other accessions.

Length of leaflets

The length of leaflets showed significant variation among the accessions studied as revealed by analysis of variance (ANOVA). The accession R5P8 (25.92) was recorded to have the highest length of leaflet, while the lowest was recorded in accession R7P1 (13.48), No significant differences were recorded in the accessions R5P24,R14P21,R4P29,R5P20 and R13P1 with the mean values 16.20,15.96, 16.06,16.42, 15.48 respectively.

Length of Internodes

There was significant differences among the accessions in the internode length, the highest was recorded in accession R1P10 with the mean value of (3.80), this value is significantly the same with accession R7P1 but are significantly different from the values of all other accessions, the least was recorded in the accession R13P1 with the mean value of 1.60 respectively.

Table 1: Some Morphological characteristics of the Date Palm accession

Parameter	Plant height (4 weeks)	Plant height (8 weeks)	Plant height (12 weeks)	Plant height (16 weeks)	Plant height (20 weeks)	Plant height (24 weeks)	Length of petiole	Width of leaves	Girth of plant
R13P9	18.00±0.58^{e}	18.00±3.21^{de}	18.83±1.36^{e}	20.00±1.00^{g}	22.67±1.20^{def}	23.33±1.76^{fg}	2.47±0.07^{de}	2.63±0.59^{c}	8.71±0.06^{c}
R16P31	16.13±0.88^{f}	16.33±5.17^{e}	22.00±2.65^{de}	24.67±2.60^{ef}	28.00±0.58^{cd}	29.33±0.67^{de}	2.77±0.07^{cd}	3.10±0.59^{b}	8.01±0.06^{c}
R6P20	13.33±0.29^{h}	22.00±1.53^{cd}	22.33±2.19^{de}	23.00±2.52^{efg}	25.20±1.11^{d}	29.00±0.58^{de}	2.43±0.07^{de}	3.50±0.36^{a}	6.00±0.06^{j}
R5P8	13.00±0.50^{h}	17.67±1.45^{de}	18.67±2.33^{e}	20.33±0.33^{g}	23.002.751^{de}	25.67±3.38^{bcd}	2.33±0.09^{ef}	2.37±0.34^{cd}	10.00±0.06^{a}
R3P22	12.50±0.06^{hi}	18.00±5.29^{d}	19.33±3.93^{e}	21.67±2.91^{fg}	27.50±1.61^{cde}	28.17±0.17^{cde}	2.30±0.06^{ef}	1.10±0.55^{d}	7.10±0.06^{fg}
R5P24	13.67±0.54^{fg}	26.50±1.04^{abc}	26.50±1.26^{bc}	28.17±0.73^{d}	28.83±0.44^{cd}	31.33±2.85^{d}	2.43±0.30^{de}	3.17±0.67^{b}	6.79±0.06^{h}
R1P18	22.83±3.77^{a}	24.17±2.46^{bcd}	29.67±3.28^{ab}	31.00±0.58^{bc}	33.67±2.85^{ab}	34.17±4.62^{cd}	3.87±0.32^{ab}	3.07±0.30^{b}	7.50±0.06^{e}
R1P10	18.87±2.00^{e}	27.33±1.76^{abc}	30.67±1.67^{a}	32.17±1.96^{b}	32.83±3.35^{b}	38.67±1.33^{b}	3.00±0.76^{c}	2.67±0.60^{bc}	6.00±0.06^{j}
R7P1	17.37±0.58^{ef}	25.67±5.17^{bcd}	25.67±3.18^{bcd}	25.83±0.44^{def}	28.00±0.58^{cd}	28.33±0.33^{def}	2.53±0.03^{d}	2.53±0.26^{cd}	6.80±0.06^{h}
R14P21	16.50±0.32^{f}	22.67±2.19^{cd}	24.33±2.03^{cd}	21.33±4.70^{fg}	16.67±5.70^{g}	21.33±3.84^{gh}	2.03±0.09^{ef}	2.67±0.33^{bc}	7.80±0.06^{d}
R15P6	21.00±0.58^{b}	26.00±2.65^{abc}	26.17±4.68^{bc}	27.33±4.10^{de}	27.67±3.53^{cde}	33.53±3.50^{d}	4.27±0.82^{a}	1.93±0.18^{cd}	6.99±0.06^{gh}
R4P29	12.00±0.58^{i}	20.67±1.56^{cd}	20.97±1.45^{de}	21.17±2.09^{fg}	21.50±2.02^{efg}	27.37±4.94^{ef}	2.20±0.38^{ef}	2.07±0.54^{cd}	8.00±0.06^{c}
R4P12	22.00±0.58^{a}	22.67±5.70^{cd}	25.67±3.84^{bcd}	28.03±0.98^{d}	28.50±1.04^{cd}	29.67±0.88^{de}	2.57±0.09^{d}	2.53±0.49^{cd}	7.00±0.06^{fg}
R24P9	20.27±0.37^{c}	23.00±2.65^{cd}	26.00±4.51^{bc}	29.33±3.38^{cd}	34.00±4.04^{ab}	36.67±3.53^{c}	1.87±0.27^{ef}	2.57±0.07^{cd}	6.50±0.06^{i}
ZARIYA	18.60±0.78^{e}	27.33±0.93^{abc}	28.33±1.45^{b}	35.00±3.21^{a}	35.00±3.25^{a}	38.33±2.19^{b}	2.17±0.20^{ef}	2.53±0.49^{cd}	7.50±0.06^{e}
R9P2	18.73±0.56^{de}	24.40±4.58^{bcd}	24.67±2.60^{cd}	26.33±0.67^{de}	31.67±1.67^{b}	34.33±3.18^{cd}	4.10±0.46^{a}	2.47±0.32^{cd}	5.20±0.06^{k}
R5P20	20.13±0.20^{c}	20.77±4.30^{cd}	28.67±0.88^{b}	30.67±1.20^{c}	30.83±2.20^{bc}	31.67±0.88^{d}	2.33±0.44^{ef}	3.17±0.43^{b}	5.20±0.06^{k}
R13P1	20.50±3.55^{c}	21.47±0.38^{cd}	28.67±0.67^{b}	28.67±1.20^{d}	30.67±3.53^{bc}	32.50±2.84^{d}	3.33±0.47^{bc}	3.23±0.54^{ab}	8.00±0.06^{c}
R13P5	15.47±0.32^{g}	21.77±1.07^{cd}	29.93±2.54^{ab}	29.33±1.76^{cd}	30.67±4.91^{bc}	39.00±0.58^{a}	3.33±0.60^{bc}	3.40±0.32^{a}	8.10±0.06^{b}
R2P4	17.67±4.81^{ef}	19.33±1.20^{d}	24.67±2.40^{cd}	25.00±4.04^{def}	28.17±2.20^{cd}	35.17±3.88^{c}	2.27±0.15^{ef}	2.87±0.47^{bc}	5.10±0.06^{k}
R9P12	19.33±1.20^{d}	21.83±2.52^{cd}	24.67±2.40^{cd}	25.33±1.45^{def}	26.50±1.32^{cde}	30.17±0.73^{de}	3.77±0.90^{ab}	2.43±0.46^{cd}	5.10±0.06^{k}
Total	17.85±0.780	24.62±0.90	26.13±0.81	27.80±0.78	28.67±0.83	25.48±0.66	2.78±0.12	2.67±0.11	7.19±0.14

Values are mean±standard errors, values with different letter(s) in the same column are significantly different at P≤0.05.

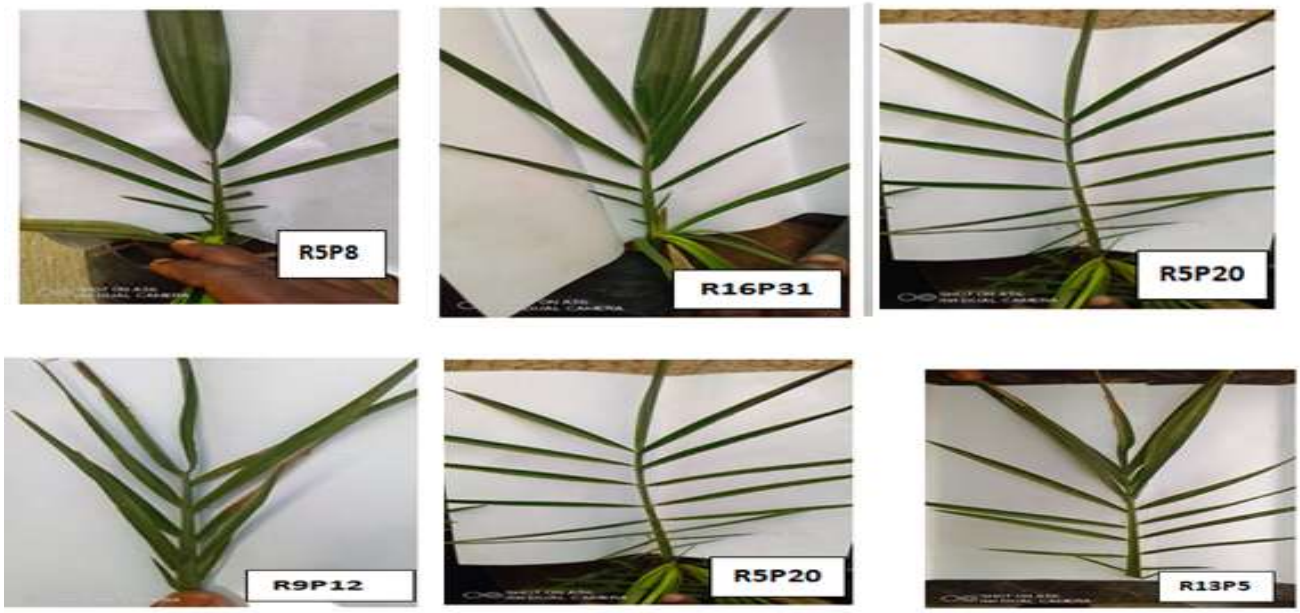

Plate 1: Leaf morphology of some accessions showing opposite arrangement of leaflets

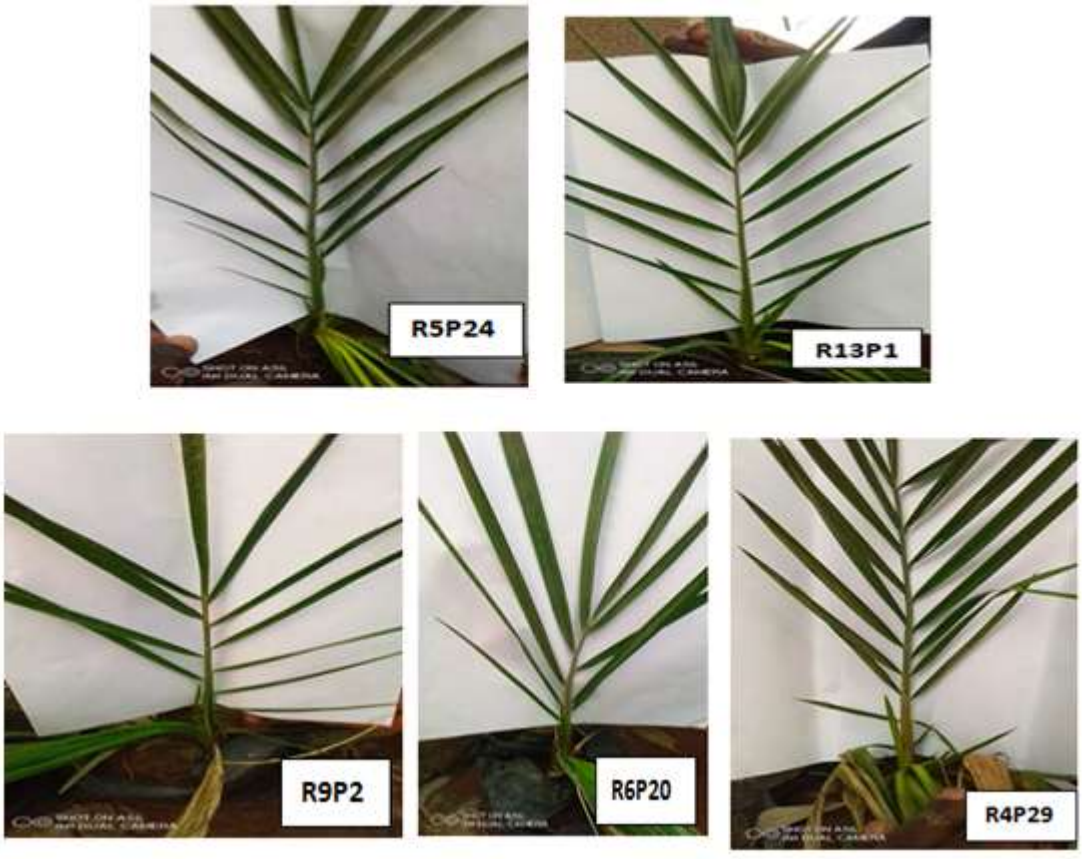

Plate 2: Leaf morphology of some accessions showing alternate arrangement of leaflets

The pronounced variation observed in the vegetative characters revealed the broad range of variability among the accessions which might be an indication of phenotypic diversity in relation to varietal differences. Hanane and Halima (2020) reported that many traits related either to vegetative and reproductive organs could be a useful tool to assess phenotypic diversity and constitute a complementary approach for other characterization methods.

Furthermore, (Salem *et al.,* 2008; Eissa *et al.,* 2009; Hammadi *et al.,* 2009) also reported that Morphological traits such as plant height, length of petiole, girth of plant , length and grouping of spines, spathe, fruit and spideces possess quantitative markers mainly used for identification, description, differentiation and characterization of date palm cultivars.

However, most accessions gave different results in relation to the different parameters taken on the morphology, this agrees with the report by Djerouni *et al.*(2015) who opined that Vegetative characteristics can be considered as a principle to know the differences between the date palm varieties, Mohamed *et al.* (2014) also affirmed in their study of 28 Mauritanian date palms, Haider *et al.* (2 015) reported in their study on the sixteen Pakistani palm dates varieties from different origins in terms of vegetative characteristics that the pinna number, length and width and the Leaf palm length are characteristics that help to differentiate between the types of date palm.

Leaf width which ranged from 1.10 cm-3.40 cm among the studied accessions is statistically among the traits causing variability; this is in contrast to the report of El-Merghany and Al Daen (2014) who found no significant difference in leaf base width of date palm cultivars under Toshki conditions in Egypt. The result of this study is similar to the report by Saleem *et al*. (2008) on the study of morphological variability in some Mauritanian date-palm and opined that leaf width to be an important discriminant parameter among their cultivars. Leaf width was found to be a measure of variation among the studied date palm cultivars. (Faqir *et al.,* 2018)

In addition, Faqir *et al.* (2016), also observed in their study on some pakistani date palm varieties, They opined that Leaf length is an important characteristic that can discriminate among the cultivars.

The significant variations in the girth size among the accessions revealed an interesting one. Because the size of the girth in palm crops indicates evidence of maturity, (Marie *et al.,* 2007). moreover, variations in girth size might be due to the division and enlargement of parenchymatous cells in the ground tissue (secondary growth) which is genetically controlled by the process of cell division. However Marie *et al.* (2007) further opined that repeated divisions cause increase in girth of stem and this type of growth is referred to as diffused secondary growth. The accession R5P20 with the highest girth size is however important in the development of breeding programmes for growth selection among the accessions. In contrast, El-kosary *et al.* (2009) in their Comparison study on Barhee cultivar and two strains of Barhee palm seedling in Egypt, found slight variation in the girth that was non-significant.

The length of leaflets recorded in this study are of the short type, this is in conformity to reported of Ahmed *et al*. (2016) who opined that the leaves less than less than 325 cm are regarded as short. The variations recorded in the leaflets length might be due to varietal differences among the accessions.

The internode length play an important role in the growth and health in plants, this has been supported by several authors like Pearson *et al.* (1995) who reported in their study that the Final stem length of plants are determined both by number of internodes and internode lengths, the variations in the internode length recorded among the accessions might be due to varietal differences or environmental conditions, Carvalo *et al.* (2002) also reported in their study on varieties of *Chrysanthemum spp* and concluded that the internodal length can be an easy visible indicator of a plant's health and productivity, but can also be affected by several factors which includes fertilizer application, sunlight and other environmental conditions.

CONCLUSION

This study highlighted some strong relationship among some accessions with regard to some quantitative vegetative characteristics which has proved that morphological markers are very useful in cultivars characterization. Thus, will serve as a baseline information to select morphologically distinct accessions for breeding and development of the fruit crop.

Declaration of Interest

The Authors declared no conflict of Interest

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